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DEVELOPMENT OF THE EAST SIBERIAN UNIFIED ELECTRIC POWER NETWORK

CIA/RR EM 61-20

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CENTRAL INTELLIGENCE AGENCY
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FOREWORD

The purpose of this memorandum is to describe the development of the East Siberian 500-kilovolt power network. The network will provide the electric power base for the development of power-intensive electrochemical and electrometallurgical industries in East Siberia and, in addition, will supply power to West Siberia and the Urals. Soviet long-range plans for the development of the national economy foresee that East Siberia will produce more than 20 percent of the electric power generated in the USSR in 1980.

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Chart

DEVELOPMENT OF THE EAST SIBERIAN UNIFIED ELECTRIC POWER NETWORK*

Summary and Conclusions

The East Siberian 500-kilovolt (kv) electric power network, which is now under construction, represents one of the most important projects in the planned development of the long-term electric power capabilities of the USSR. When completed, the network will integrate, over a vast area, a series of large thermal electric powerplants, the world's largest hydroelectric powerplants, and subsidiary lower voltage transmission lines (of 110 to 220 kv).

Production of electric power in East Siberia is planned to increase from 4 percent of the total production in the USSR in 1958 to 12 percent in 1965, to 17 percent by 1975, and to more than 20 percent in 1980. Of the 60 billion kilowatt-hours (kwh) expected to be produced in that region in 1965, approximately 50 billion kwh will be produced within the network. Generating capacity of the main powerplants within the network will increase from almost 6,000 megawatts (mw) in 1962 to more than 11,000 mw in 1965, or from about 7 to 10 percent, respectively, of the total generating capacity in the USSR.

The first step in the integration of the 500-kv network, probably late in 1962, will be the interconnection of the present Irkutsk and Krasnoyarsk Power Systems. The principal components in this first stage of network development, which will unite the powerplants at Angarsk, Bratsk, Krasnoyarsk, and Nazarovo into a single system, will be the Bratsk Hydroelectric Powerplant (GES**), the Nazarovo Thermal Electric Powerplant (GRES**), and one 500-kv circuit stretching some 1,500 kilometers (km) from Angarsk to Nazarovo. As production increases at the Bratsk GES and the Nazarovo GRES, a second 500-kv circuit will be built -- the double-circuit line from Angarsk to Nazarovo is planned for operation by 1965. When the Krasnoyarsk GES goes into operation toward the end of 1965, a single 500-kv line from Nazarovo westward to the Kuzbass will be put into service, to be followed in several years by an identical second line. The double-circuit

* The estimates and conclusions in this memorandum represent the best judgment of this Office as of 1 September 1961.

** Subsequent references to specific hydroelectric powerplants (gidroelektricheskaya stantsiya) have been abbreviated to "GES." Similarly, state regional (thermal) electric powerplants (gosudarstvennaya rayonnaya elektricheskaya stantsiya) have been abbreviated to "GRES."

500-kv transmission line will then span 2,000 km from Angarsk to the Kuzbass.

The long-range goals (1970 and beyond) for electric power development in East Siberia call for eventual unification of all existing and planned large thermal electric and hydroelectric powerplants by an extensive network of 500-kv lines. Powerplants will be located to utilize the cheap sources of power on the Yenisey and Angara Rivers and the low-cost coal of the Kuzbass, Krasnoyarsk, and Irkutsk regions. Initially, power from these sources will be used locally to supply large chemical, nonferrous, and nuclear materials facilities as well as other industries under development. During the later stages of development, beginning after 1965, increasingly larger exports of electric power are envisioned from East Siberia to the Kuzbass, Novosibirsk, Tomsk, and even the Urals regions. Ultimately this power system will become one of the largest in the USSR, not only providing for long-distance transmission but also having the flexibility to transfer significant amounts of power from area to area because of varying peak load conditions in different time zones.

I. Introduction

The USSR is constructing a 500-kv transmission network in East Siberia that initially will be integrated with the Irkutsk and Krasnoyarsk Power Systems and that by 1975 will be joined to power systems of the Kuzbass, Novosibirsk, Tomsk, and Altay regions. The 110-kv and 220-kv transmission networks of both the Irkutsk and Krasnoyarsk Power Systems, now operating independently, are developed to a stage that will permit integration with the 500-kv network as it is constructed (see the chart*).

The Irkutsk Power System currently in operation serves the Irkutsk-Cheremkhovo industrial area by means of 110-kv and 220-kv transmission lines, the greatest concentration of lines occurring in the vicinity of Angarsk. This power network also is joined to Bratsk by one 220-kv line. Power for the electrified Trans-Siberian Railroad comes from 110-kv lines stretching almost 800 km from Slyudyanka on Lake Baykal to Tayshet near the boundary of Krasnoyarskiy Kray. Smaller voltage distribution lines radiating from the main network serve the needs of consumers in the populated districts along the Trans-Siberian Railroad. Electric power is currently generated by one hydroelectric powerplant and several thermal electric powerplants (see the table**).

The Krasnoyarsk Power System is comprised of 110-kv and 220-kv transmission lines 1/*** serving consumers in the immediate vicinity of Krasnoyarsk and 110-kv lines for the electrified Trans-Siberian Railroad stretching 600 km from Nazarovo eastward to Tayshet. Development of this network has lagged behind that of Irkutsk and will continue to lag until well after 1965. Until the thermal powerplant at Nazarovo went into operation, in July 1961, the Krasnoyarsk Power System was served primarily by one thermal powerplant located in the city of Krasnoyarsk.

Construction of the East Siberian 500-kv network will create an electric power base for the further growth of the East Siberian region and will make possible the fulfillment of Soviet economic plans for exploiting vast deposits of low-quality Siberian coal and developing cheap hydroelectric power for the benefit of other parts of the country. Attainment of the goal for electric power in this region also will represent an important technical achievement in power engineering, for it will integrate into one power system a number of "super"† thermal

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* Following p. 4.

** The table follows on p. 4.

*** For serially numbered source references, see the Appendix.

† A designation used generally by the USSR to denote thermal powerplants with capacities of 1,200 mw or more.

Table

Estimated Capacity of Main Electric Powerplants
in the East Siberian Power Network a/
1958-62 and 1965

Megawatts

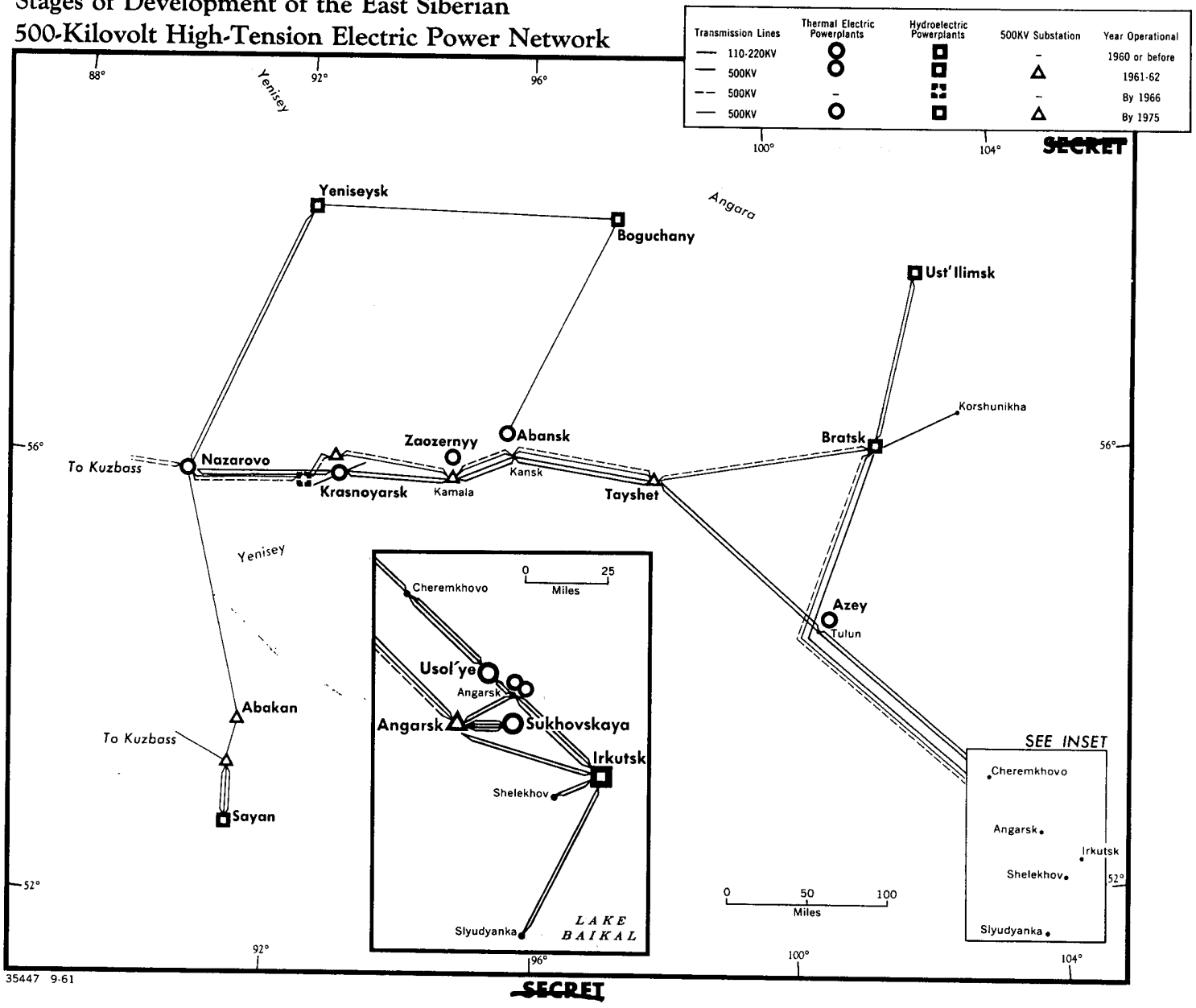
	1958	1959	1960	1961	1962	1965
Irkutsk Power System						
Irkutsk GES	660	660	660	660	660	660
Angarsk TETs 1	275	275	275	275	300	300
Angarsk Sukhovskaya TETs	0	100	550	900	1,100	1,100
Usolye TETs	0	0	120	120	220	320
Angarsk Refinery TETs	0	0	0	50	100	300
Bratsk GES	0	0	0	900	2,500	4,500
Total	935	1,035	1,605	2,905	4,880	7,180
Krasnoyarsk Power System						
Krasnoyarsk TETs	244	302	484	484	484	484
Nazarovo GRES	0	0	0	300	600	1,400
Krasnoyarsk GES	0	0	0	0	0	2,000
Total	244	302	484	784	1,084	3,884
Total network a/	0	0	0	0	5,964	11,064

a. It is estimated that the actual joining of the Irkutsk and Krasnoyarsk Power Systems will occur in 1962. Before that time the power systems will operate independently.

powerplants, a series of the largest hydroelectric powerplants in the world, and a grid of the longest transmission lines in the world that will carry the highest voltage in use anywhere.

Production of electric power in the East Siberian region is planned to increase from 4 percent of the total production in the USSR in 1958 to 12 percent in 1965, to 17 percent by 1975, and to more than 20 percent by 1980. Of the estimated 60 billion kwh to be produced in East Siberia in 1965, approximately 50 billion kwh will be produced within the 110-kv to 500-kv network of the Irkutsk and Krasnoyarsk Power Systems.

Stages of Development of the East Siberian 500-Kilovolt High-Tension Electric Power Network



In addition to making cheap electric power available locally for power-intensive conventional industry such as production of nonferrous metals and chemicals, the network also will serve major nuclear materials enterprises within the East Siberian region.

The main purpose of 500-kv transmission is to transmit large amounts of electric power economically. One 500-kv circuit, for example, can transmit 1,000 mw of power, roughly 5 times the normal carrying capacity of a 220-kv circuit or about 20 times the capacity of the more common 110-kv circuit. A 500-kv transmission system relies on 220-kv, 110-kv, and lower voltage lines, however, to distribute power to consumers.

Although construction of additional 110-kv and 220-kv lines radiating from the 500-kv grid is expected to continue, the discussion that follows is limited to the basic development of the 500-kv power network and the main powerplants that will serve this network. Because the existence of 500-kv transmission implies the movement of large amounts of electric power, an attempt also has been made to indicate generally where the power will be consumed.

II. First Stage of Development, 1962

The first circuit of the East Siberian electric power network will extend about 1,500 km from Angarsk in the east to Nazarovo in the west and will be composed of five sectors, with four intermediate substations at Bratsk, Tayshet, Kamala, and Krasnoyarsk. This circuit will be completed in 1961 except for the 230-km segment between Kamala and Tayshet. Completion of the latter segment by the end of 1962 will unite the Irkutsk and Krasnoyarsk Power Systems and about 6,000 mw of generating capacity in the initial development of the network. Transfers of power from the Irkutsk System toward Krasnoyarsk probably will begin in 1962.

A. Construction of Transmission Lines

1. Bratsk-Angarsk Sector

Construction of the Bratsk-Angarsk 500-kv circuit, the most publicized segment of the entire East Siberian electric power network, has been in progress since 1958. Activation of the circuit is planned to coincide with initial operation of the Bratsk GES in 1961. 2/ It is believed that the Angarsk substation, the terminal point of the Bratsk-Angarsk 500-kv line, 3/ is being constructed to supply primarily a nearby nuclear materials enterprise.

The Bratsk GES is planned for operation with an initial capacity of 900 mw at the end of 1961 and to reach its full capacity

of 4,500 mw in 1963, 4/ making it the largest single producer of electric power in the world. Because there are now no large consumers at Bratsk, 5/ most of this power will be sent out over 500-kv lines to Angarsk and Tayshet.

A 1,100-mw thermal powerplant at Angarsk, the Sukhovskaya TETs,* 6/ also serves the nuclear materials enterprise and could be considered to be the power source at the eastern end of the 500-kv line.

2. Bratsk-Tayshet Sector

The Bratsk-Tayshet 500-kv circuit has been under construction for several years and probably will be completed by the end of 1961. This line will pass through a major 500-kv substation near Tayshet, which also serves as a step-down substation for lower voltage lines of the electrified railroad. 7/ Part of this substation supplying the railroad was put into operation in 1960. 8/ The primary purpose of the Tayshet substation probably will be to serve railroads radiating in four directions as well as the future Tayshet Metallurgical Combine.

3. Nazarovo-Krasnoyarsk Sector

The Nazarovo-Krasnoyarsk 500-kv circuit is under construction and is scheduled for completion in the last quarter of 1961. 9/ It will run south of the Trans-Siberian Railroad and will pass through the 500-kv substation located near the Krasnoyarsk GES. 10/ This sector of the line will be served by the Nazarovo GRES, which will have a capacity of 300 mw by the end of 1961 and a capacity of 1,400 mw by 1965. 11/

4. Krasnoyarsk-Kamala Sector

The 154-km section of the 500-kv circuit from Krasnoyarsk to Kamala was completed in May 1961. 12/ The Krasnoyarsk terminus is a 500-kv substation located on the left bank of the Yenisey River, 13/ probably just north of the city near the site of a future aluminum plant at Korkino. The line crosses the river at a village named Yermolayevo, 14/ believed to be located about 15 km northeast of Krasnoyarsk, and continues along the right bank of the river 15/ for an unknown distance before heading toward Kamala.

* Teploelektrotsentral, a type of thermal powerplant that produces both heat and electric power.

It is not known whether a 500-kv substation is now ready for operation near Kamala. A substation in the vicinity is indicated, however, by the fact that the Zaozernyy GRES is reported to be under construction. 16/ This GRES may be the same as the Irsha GRES, which is planned to have a capacity of 1,200 to 2,400 mw. Zaozernyy and Irsha are both located within 15 km of Kamala.

The Krasnoyarsk-Kamala line will be served initially by the Nazarovo GRES and also by the Krasnoyarsk GES and the Zaozernyy GRES after 1965.

5. Kamala-Tayshet Sector

From information available it is estimated that completion of the line segment between Kamala and Tayshet will not be accomplished until late in 1962, when the Bratsk GES is scheduled to increase production significantly and when the first exchange of power between the Irkutsk and the Krasnoyarsk Power Systems probably will take place.

B. Network Capacity and Power Flows

It is estimated that by the end of 1961 there will be no 500-kv connections between the Irkutsk and Krasnoyarsk Power Systems, although transfers of power to a limited degree could take place by means of high-tension lines currently serving the electrified railroad between the two systems. By late 1962, almost 6,000 mw of generating capacity will be connected to the network, more than 4,800 mw of which will be in the Irkutsk Power System, and power may start to flow from the Bratsk GES west to Krasnoyarskiy Kray.

The 500-kv line leading from Bratsk to Angarsk will transmit little if any power during 1961, as no significant production from the Bratsk GES is expected before the end of the year. The Nazarovo GRES will supply power to the Krasnoyarsk region and to the electrified railroad as far east as Tayshet. 17/ The railroad probably will be served through the 500-kv substation at Kamala. In 1962, power from the Nazarovo GRES probably will flow eastward toward Krasnoyarsk and Kamala; from the Bratsk GES the flow will be predominantly toward Angarsk and, in smaller amounts, to Tayshet.

III. Second Stage of Development, 1963-66

The plan for the second stage of construction of the network during 1963-66 calls for the addition of a second 500-kv circuit parallel to the first and for the extension of the network to connect with the Kuzbass Power System to the west. During this period the Irkutsk Power System will become a net exporter of electric power to Krasnoyarskiy Kray.

No significant amount of power will be transmitted to the Kuzbass until after 1965. Capacity of the main powerplants in the East Siberian network by the end of 1965 (excluding that in the Kuzbass Power System) will be approximately 11,000 mw.

A. Construction of Transmission Lines

1. Second 500-Kv Circuit, Bratsk-Angarsk, 1963

Construction of the second 500-kv circuit from the Bratsk GES to Angarsk is planned for completion 2 years after the first circuit, 18/ or by the end of 1963. The line will parallel the first circuit and probably will terminate at the 500-kv substation at Angarsk.

2. Second 500-Kv Circuit, Bratsk-Tayshet-Krasnoyarsk-Nazarovo, 1965

Construction of the second 500-kv circuit leading westward from Bratsk is scheduled when the Bratsk GES nears its peak production, 19/ probably during 1964-65. It will pass through Tayshet, Kamala, and Krasnoyarsk to Nazarovo. The Bratsk-Tayshet and Nazarovo-Kamala sectors probably will be constructed concurrently with increases in production at the Bratsk GES and the Nazarovo GRES, and the Kamala-Tayshet sector, as in the case of the first circuit, probably will again be the last segment completed.

3. Nazarovo-Kuzbass 500-Kv Connections, 1966

Linking of the Krasnoyarsk and Kuzbass Power Systems by 500-kv lines is scheduled to occur when the Bratsk GES reaches its maximum output and when the first units of the Krasnoyarsk GES are put into operation, 20/ about 1965. The Nazarovo-Kuzbass connection, however, depends mainly on the operation of the Krasnoyarsk GES, 21/ from which no significant production is likely until 1966. Consequently, completion of the first 500-kv circuit may not take place until 1966. Construction of the second Nazarovo-Kuzbass circuit is expected to follow within a year or two of the first.

B. Network Capacity and Power Flows

The most significant development during 1962-65 will be the transfer of power from Irkutskaya Oblast to the Krasnoyarsk Power System. Both the direction and the amount of power flow is indicated by the following approximate power balance for the region in 1965:

	Billion Kilowatt-Hours	
	Reported Planned Consumption	Estimated Production
Irkutskaya Oblast	35 to 38 22/	38 to 43 23/
Krasnoyarskiy Kray	18 to 20 24/	14 to 16
Total*	53 to 58	52 to 59

The figures show that by 1965 Krasnoyarskiy Kray may be experiencing a power deficit roughly equal to the possible surplus in Irkutskaya Oblast, an amount on the order of 4 billion kwh. That this amount of power will flow from Bratsk to Krasnoyarskiy Kray also is indicated by other information. Available evidence indicates that production by the Bratsk GES in 1965 will be about 20 billion kwh. The two 500-kv high-tension lines and the one 220-kv high-tension line that are expected to connect the Bratsk GES with Angarsk in 1965 will be capable of carrying about 15 billion kwh per year, and 1 billion kwh in addition probably will be consumed in the Bratsk-Tayshet district. With about 16 billion kwh of the production at the Bratsk GES thus accounted for, approximately 4 billion kwh would remain to flow to Krasnoyarskiy Kray.

No transfer of power from Nazarovo to the Kuzbass is expected until after 1965, when the Krasnoyarsk GES and the line to the Kuzbass will be in operation. Through 1965, consequently, the flow from the Nazarovo GRES will be eastward toward Krasnoyarsk and Kamala.

The major planned additions to generating capacity during 1962-65 will be the completion of the Nazarovo GRES and the Bratsk GES and the installation of the first four generating units at the Krasnoyarsk GES. The total capacity of the main plants serving the 500-kv network within East Siberia by the end of 1965 will be approximately 11,000 mw if the first 2,000 mw at Krasnoyarsk GES are put into operation as planned. Should construction be speeded up at the Zaozernyy GRES in Krasnoyarskiy Kray and at the proposed Azey GRES in Irkutskaya Oblast, the total generating capacity supplying the network in 1965 would be higher by perhaps as much as 400 to 600 mw.

* The totals include some production in areas outside the main power network. Production within the network in 1965 is estimated at approximately 50 billion kwh.

IV. Third Stage of Development, After 1966

A. Expansion of the East Siberian Network

Plans for developing the East Siberian network during 1966-70 call for the construction of additional large thermal powerplants (of 1,200 to 2,400 mw) at Azey, Zaozernyy, and Abansk. The Nazarovo GRES, moreover, will be expanded to about 2,400 mw. Preliminary work is already underway on the Ust Ilimsk GES, on the Angara River 200 km north of Bratsk, which will have a capacity of 4,500 mw. Construction of the Yeniseysk GES, 280 km north of Krasnoyarsk, with a capacity of 6,000 mw, will follow the completion of the Krasnoyarsk GES on the Yenisey River. 25/ Most of the work on the Yeniseysk GES should be completed by 1970, but the plant may not be in operation until several years afterwards.

As new powerplants are added to the network, the 500-kv grid will be extended to join them, providing both a means of transmitting power and flexibility in the operation of the network. The addition of hydroelectric powerplants will allow the substitution of hydroelectric power for more expensive thermal electric power during high water periods. Furthermore, because high water periods vary on different rivers, grid interconnections between individual hydroelectric powerplants will permit a more effective utilization of water resources. Joining the hydroelectric powerplants at Bratsk, Krasnoyarsk, Ust Ilimsk, and Yeniseysk in this way will increase their guaranteed output by 1,000 mw. 26/

Other thermal electric and hydroelectric powerplants are included in the over-all development plans for 1970-75, but the plans are too tenuous for consideration at this time.

B. Integration with Adjacent Power Systems

During 1966-70 the East Siberian network will be integrated with the power systems of the Kuzbass, Novosibirsk, Tomsk, and Altay regions, forming the Central Siberian Unified Power Network. This integration will permit the use of East Siberian power to cover peak load requirements in three different time zones, thereby reducing the amount of reserve generating capacity that would otherwise have to be available in separate power systems. Integration of the Krasnoyarsk GES with the Kuzbass Power System, for example, will reduce by 650 mw the amount of thermal generating capacity needed to cover peak loads in the Kuzbass. 27/

In the final stage of development during 1970-75, the East Siberian network will supply electric power over ultra-high-voltage direct current (DC)* transmission lines as far west as the Urals region, 28/ completing the principal plans for integration of power networks and creating ties with power networks of the European USSR. By 1980 the largest power-producing network of the country will be the Central Siberian Unified Power Network, 29/ within which the East Siberian network will furnish more than 20 percent of the total Soviet production of electric power. 30/

* Because of a particular suitability for long-distance transmission of bulk power, DC lines have been included in the East Siberian power scheme. Some technical difficulties, however, still remain to be overcome before this type of line becomes fully operational.

APPENDIX

SOURCE REFERENCES

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this memorandum. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

Except for CIA finished intelligence, all sources in this memorandum are evaluated RR 2.

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